

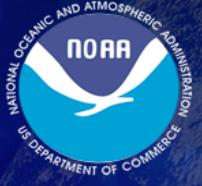


# Current Status of NOAA IASI and CrIS/ATMS retrieval algorithm

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Eric Maddy (1), Haibing Sun (1), Chris Barnet (2), Walter  
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(1) NOAA/NESDIS/STAR - DELL  
(2) NOAA/NESDIS/STAR

NASA Sounder Science Meeting, November 5<sup>th</sup> 2010  
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# Outline

- NOAA/NESDIS/STAR long term hyper spectral sounding strategy
- Status of the IASI algorithm
- AIRS – IASI comparisons
- Activities in preparation for CrIS/ATMS operations



# NOAA/NESDIS/STAR long term hyper spectral sounding strategy

## Initial Joint Polar System (IJPS):

An agreement between NOAA & EUMETSAT to exchange data and products.

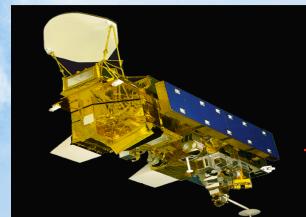
### 2006 - 2010

- *Migrate the AIRS/AMSU/MODIS retrieval algorithm into operations with METOP IASI/AVHRR (2006,2011,2016)*
- *IASI operations approved on June 18<sup>th</sup> 2008; effectively operational since August 14<sup>th</sup> 2008*
- *Currently studying differences between instruments (AIRS, IASI and CrIS in simulation)*

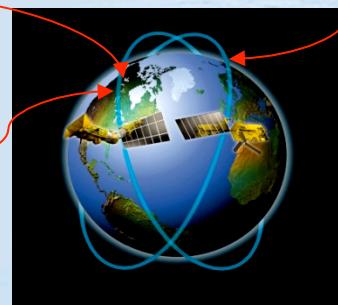
### 2010 ~2025

- *Migrate the AIRS/IASI algorithm into operations for NPP (~2011) & NPOESS (~2013,~2018) CrIS/ATMS/VIIRS (NOAA NDE program)*

AQUA  
1:30pm orbit  
(May 4th 2002)



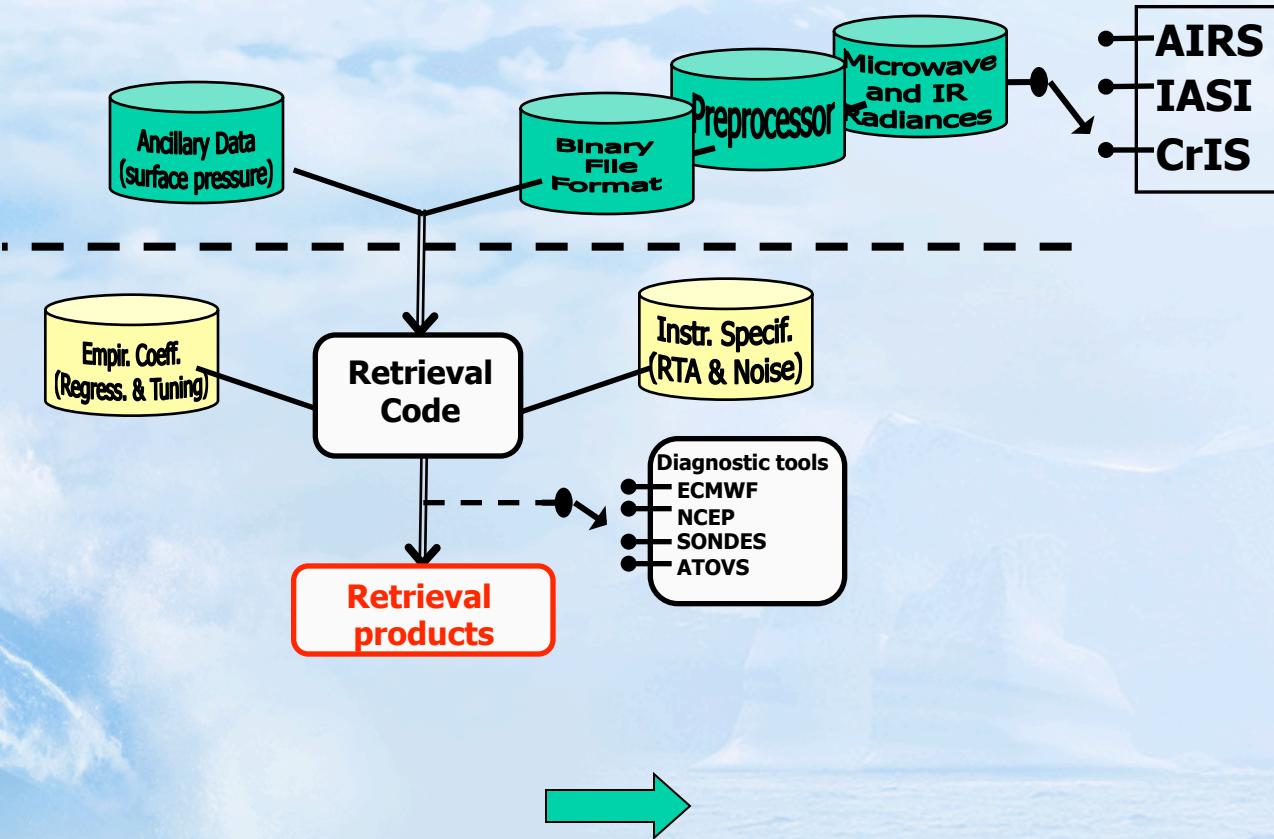
NPP  
1:30pm orbit  
(2011)



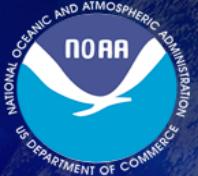
METOP  
9:30am orbit, (October 19<sup>th</sup> 2006)



# The NOAA/NESDIS/STAR processing system is a modular design compatible with multiple instruments



A long term uniform data record of atmospheric variables (cloud cleared radiances, temperature, water vapor, trace gases) by employing the same retrieval algorithm and the same underlying radiative transfer spectroscopy



# History of IASI's Retrieval System

- **Pre-operations (2007):**

IASI RTA v.7a, preliminary tuning, preliminary channel list selection, preliminary first guess regression.

- **Operational System (2008):**

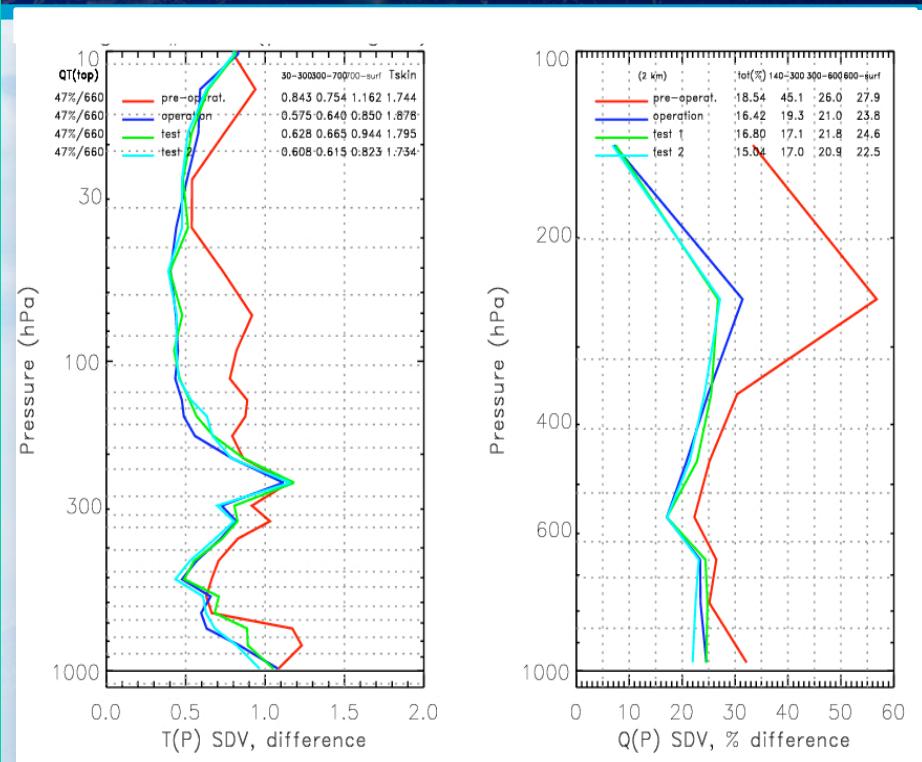
IASI RTA (SARTA v.9a), updated tuning (using ECMWF), improved first guess regression training (using “focus day” Oct. 19, 2007). Global validation wrt AIRS, ECMWF, RAOBs completed.

- **Operational System Update (2009):**

Updated RTA (SARTA v.10), updated radiance bias tuning, two “focus days” used for first guess regression training (Oct.19,2008 & Jan.22, 2009), ILS shift studies completed, CCR algorithm under improvement.

- **Test System II (2010):**

Four “focus days” (Oct.19,2008; Jan.22, 2009; August 22, 2009; May 11, 2010) used for first guess regression training



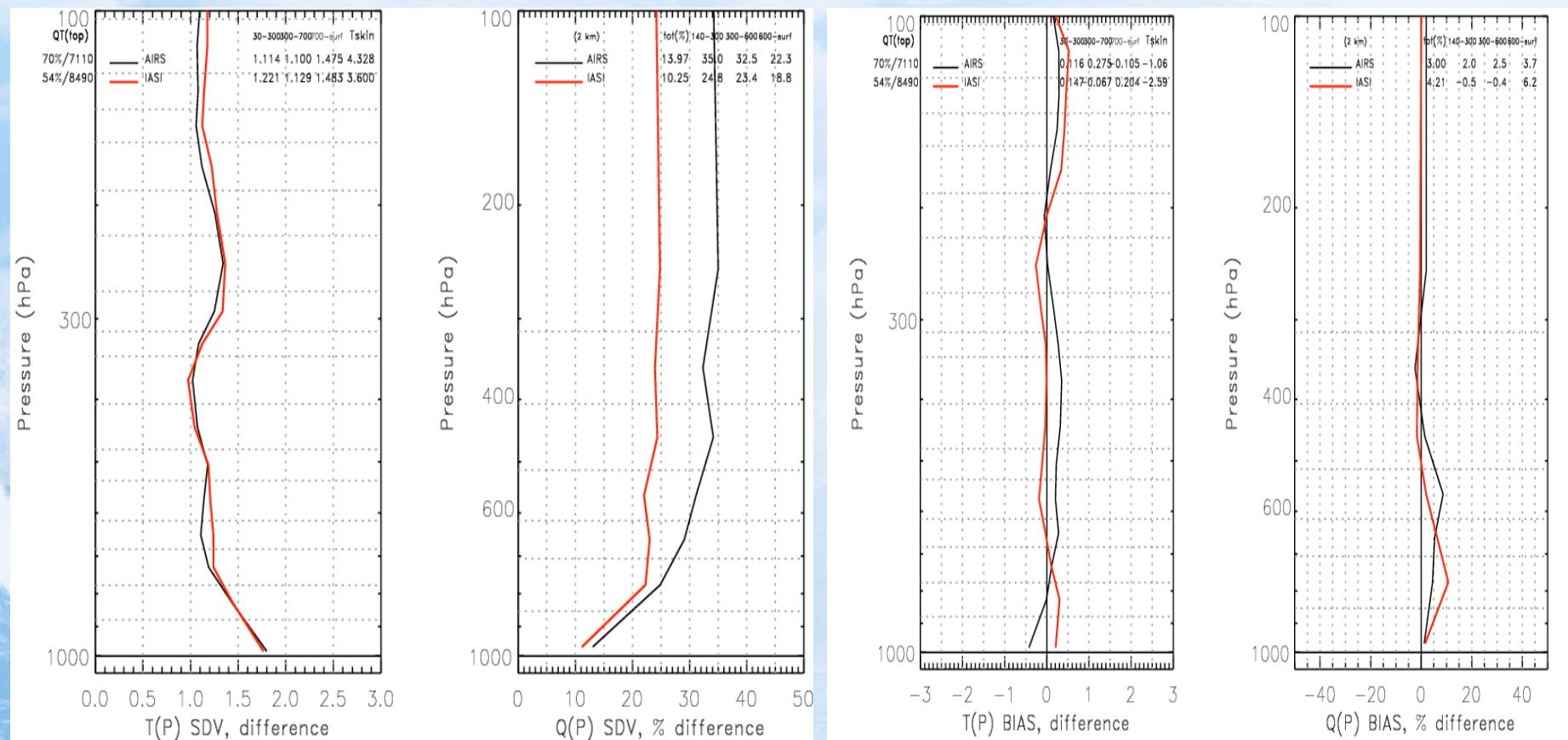
(IASI Granule 83, Northern Polar Region)

- Backward and forward compatibility of the NOAA retrieval system is key for making updates, reprocess, testing for improvements.



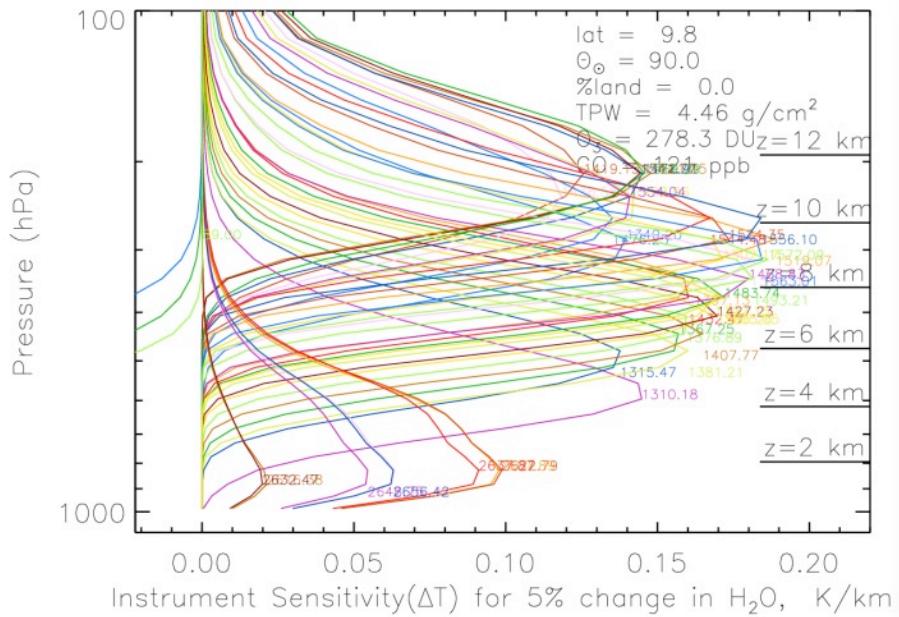
# AIRS & IASI Comparison

AIRS Sept. 06, 2002; IASI Oct. 19, 2007 Global statistics wrt ECMWF

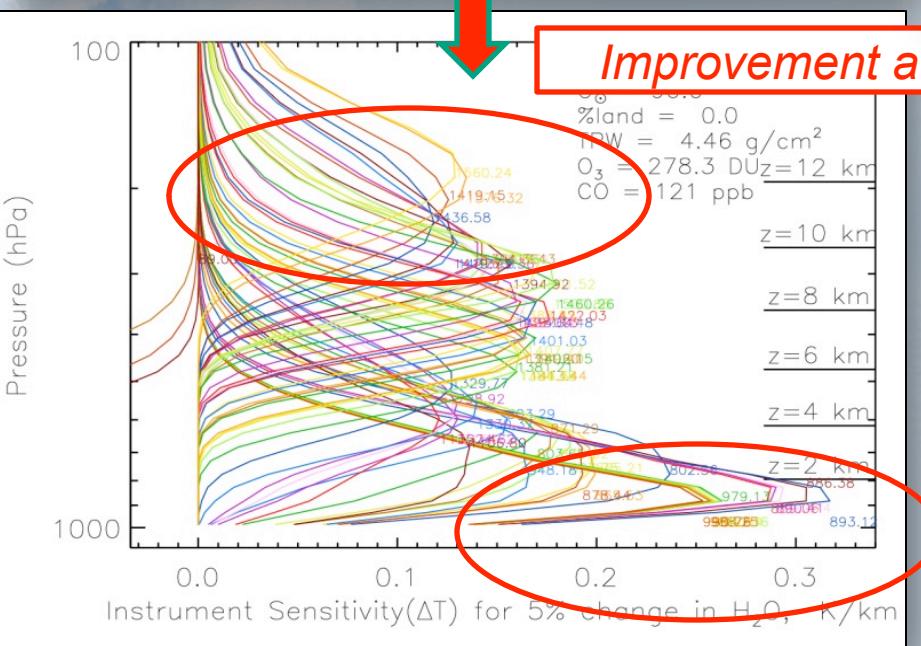
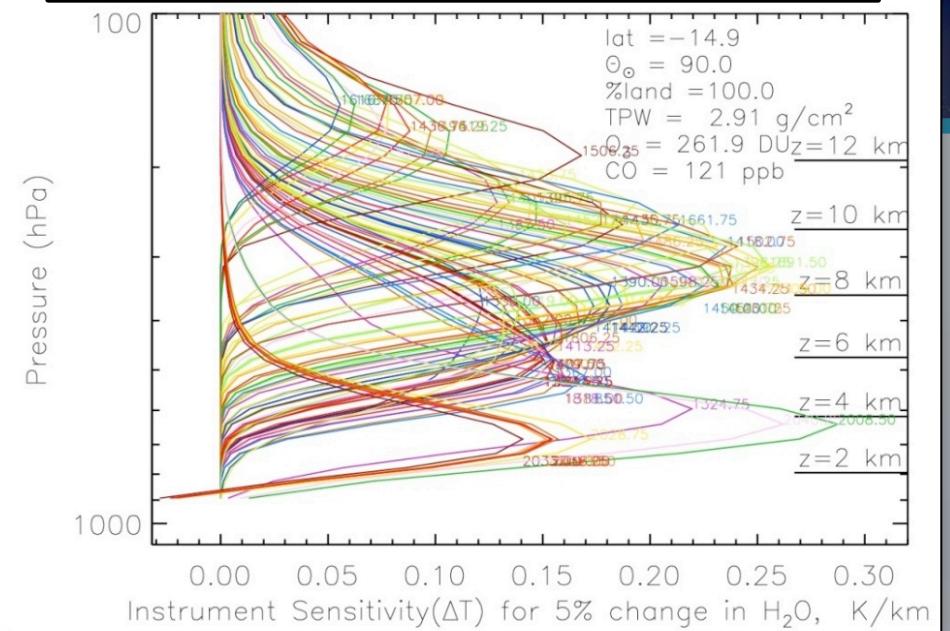


- IASI Retrieval System is being built to emulate AIRS system: the exact same executable is being used for both instruments.
- AIRS and IASI have comparable performance; IASI RMS & SDV water vapor performs better (~10%). See next slide.
- Extensive validation study using RAOBs is in preparation (M. Divakarla et al., 2010)

## AIRS v.5 water vap. channel list



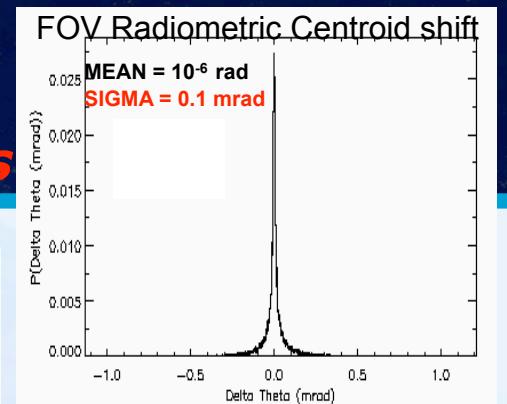
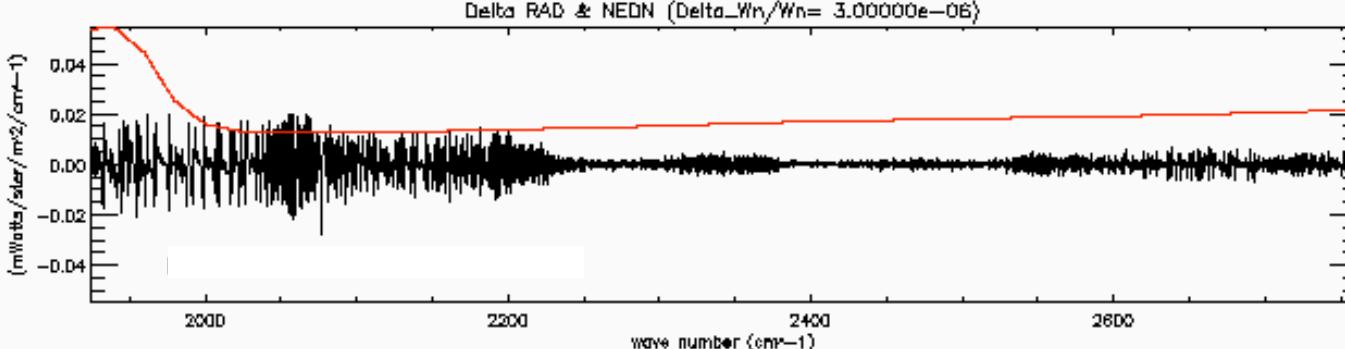
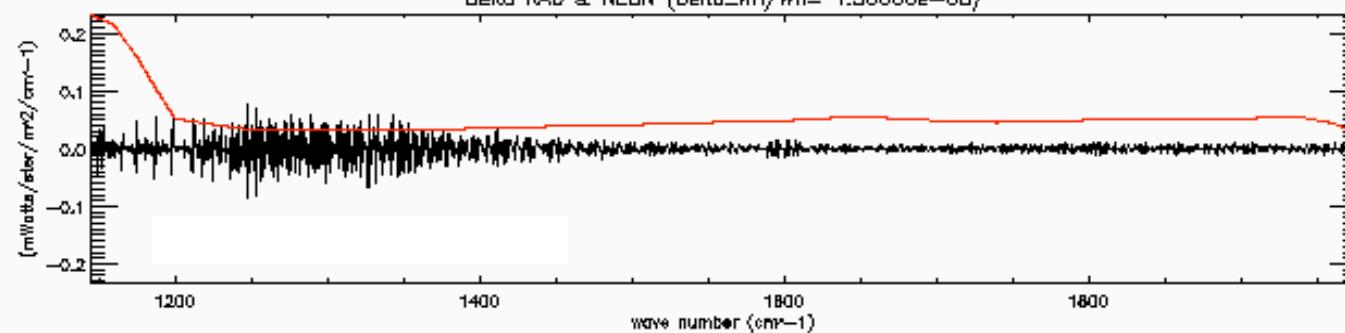
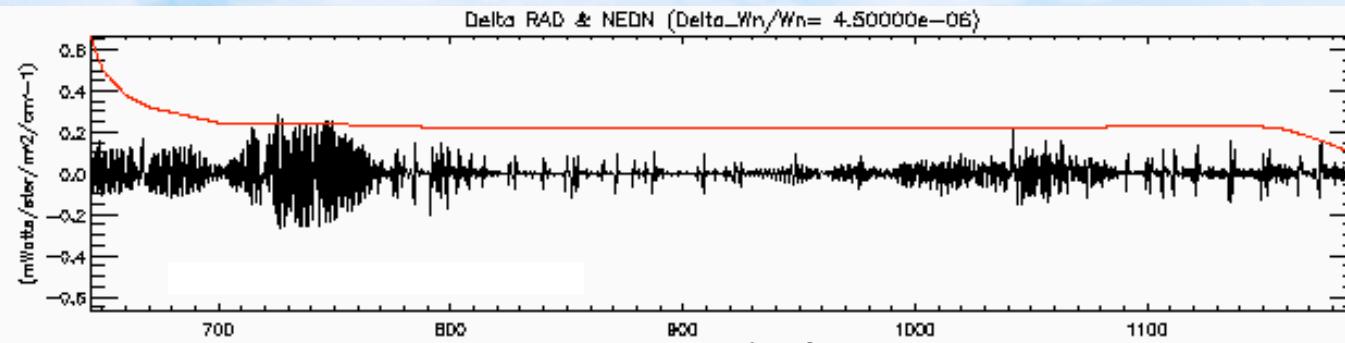
## IASI water vapor channel list



- Present SW channels used in AIRS water vapor retrieval (2600cm-1 region) are indeed sensitive to HDO
- Should they be replaced with other lower trop. sensitive channels?
- An optimization attempt (left) is under way (800-900cm-1 region), including re-optimization of regularization parameters (damping term, trapezoids)
- Recent paper [Liang et. 2010] highlights need for improved AIRS UT/LS water vapor sensitivity as well.
- Possible candidate for AIRS version 6?



# IASI Instrument Line Shift Effects in presence of non uniform scenes: *error induced is negligible except for very rare cases*



Band 1  
**3 sigma shift error vs  
NEDN**

Band 2  
**1 sigma shift error vs  
NEDN**

Band 3  
**2 sigma shift error vs  
NEDN**



- **Pre-operations (2007):**

IASI RTA v.9, preliminary tuning, preliminary channel list selection, preliminary first guess regression.

- **Operational System (2008):**

IASI RTA (SARTA v.9a), updated tuning (using ECMWF), improved first guess regression training (using “focus day” Oct. 19, 2007). Global validation wrt AIRS, ECMWF, RAOBs completed.

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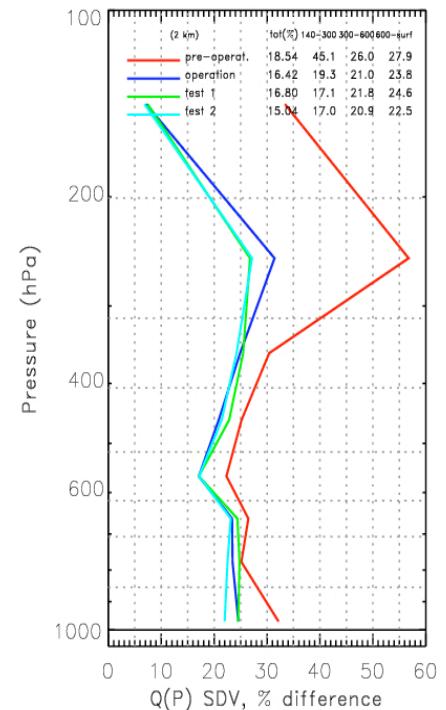
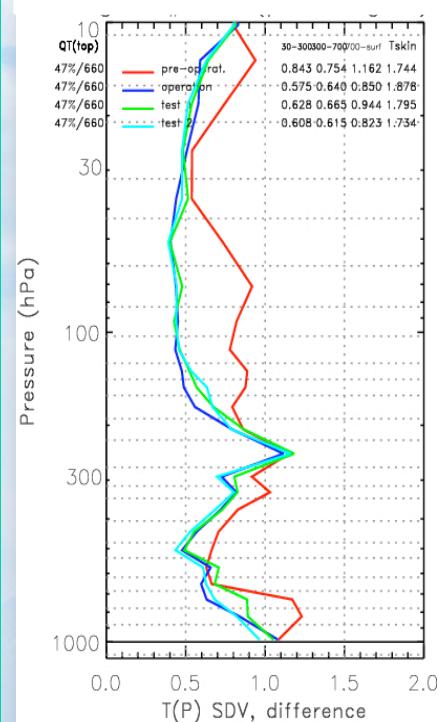
- **Test System II (2010):**

Four “focus days” (Oct.19,2008; Jan.22, 2009; August 22, 2009; May 11, 2010) used for first guess regression training



- **Coming next (2010-2011):** *Updated retrieval channel lists, AVHRR cloud mask, updated radiance tuning using co-located RAOBs, averaging kernels. Stay tuned!*

# History of IASI's Retrieval System



(IASI Granule 83, Northern Polar Region)

- Backward and forward compatibility of the NOAA retrieval system is key for making updates, reprocess, testing for improvements.



# NOAA Unique CrIS/ATMS Product System (NUCAPS) Project Plan

- Tasks:
  - Defined in “FY09\_Polar\_CrIS-ATMS\_star\_v2\_www.ppt” (SPSRB PSDI) [http://www.star.nesdis.noaa.gov/smcd/spb/iosspdt/qadocs/NUCAPS\\_CDR/FY09\\_Polar\\_CrIS-ATMS\\_star\\_v2\\_www.ppt](http://www.star.nesdis.noaa.gov/smcd/spb/iosspdt/qadocs/NUCAPS_CDR/FY09_Polar_CrIS-ATMS_star_v2_www.ppt)
- Schedule (key milestones):
  - Preliminary Design Review – May 9, 2007
  - Critical Design Review – September 29, 2008
  - **Test Readiness Review – September 29, 2010**
  - **Code Unit Test Review – September 29, 2010**
  - Algorithm Readiness Review – November 2011
  - SPSRB Briefing – January 2012
  - Operations Commence – February 2012
  - Launch scheduled for ~2012

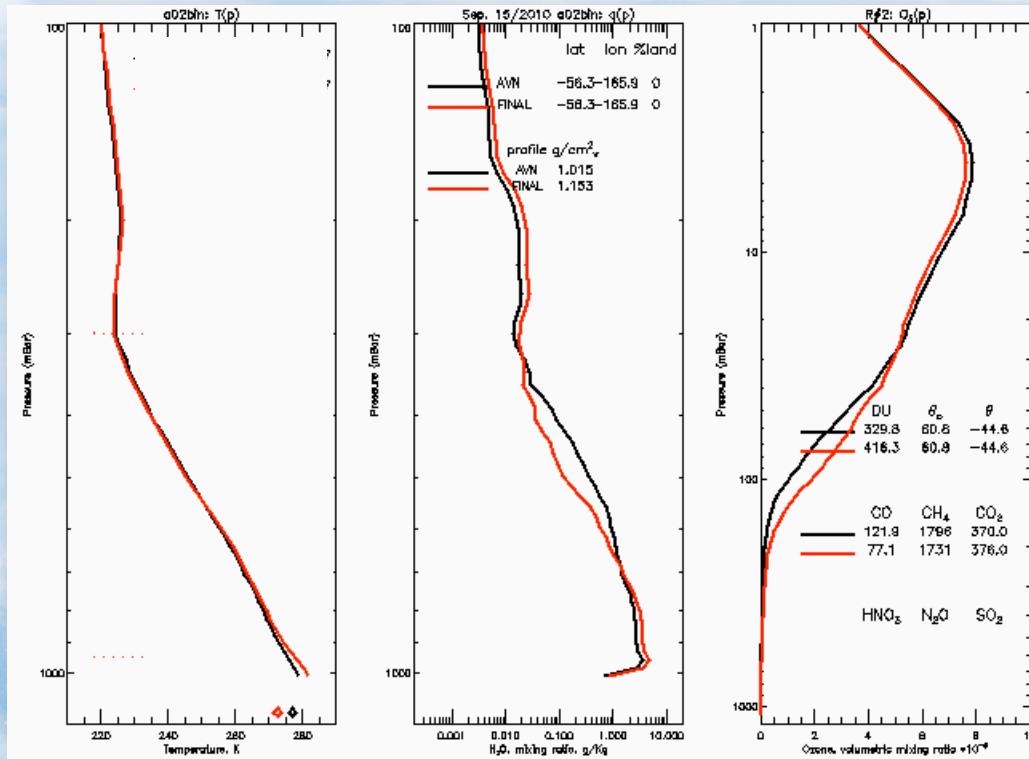


# Purpose of TRR/CUTR

- Review the status of all the open review items
- Describe the Software Architecture
- Describe the tests for the software units and show the results that the units have been successfully tested
- Establish the contents of the Delivered Algorithm Package



# CrIS/ATMS EDR output test example: temperature, water vapor, trace gases



Final retrieval (red) vs AVN forecast (black)

- **LEFT:** temperature profiles, circles are skin temperature retrievals, dot lines represent cloud layers
- **MIDDLE:** water vapor profiles; total precipitable water is reported as well
- **RIGHT:** ozone profiles; total column computations of other trace gases (CO, CH<sub>4</sub>, CO<sub>2</sub>) are reported as well
- The example shown passed the retrieval acceptance quality controls
- The retrieval shows a good performance and is able to capture the vertical structure of the “truth” profile



# Project Plan

- Tasks:
  - Defined in “FY09\_Polar\_CrIS-ATMS\_star\_v2\_www.ppt” (SPSRB PSDI) [http://www.star.nesdis.noaa.gov/smcd/spb/iosspdt/qadocs/NUCAPS\\_CDR/FY09\\_Polar\\_CrIS-ATMS\\_star\\_v2\\_www.ppt](http://www.star.nesdis.noaa.gov/smcd/spb/iosspdt/qadocs/NUCAPS_CDR/FY09_Polar_CrIS-ATMS_star_v2_www.ppt)
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  - Launch scheduled for ~2012



# NUCAPS Requirements – Basic Requirement 3.0 (slide taken from TRR meeting)

- **Basic Requirement 3.0:** *The NUCAPS shall generate trace gas profile products for U.S users.*
  - » [...]
  - » **Derived Requirement 3.3:** *The NUCAPS shall generate trace gas profiles for GMAO, derived from CrIS/ATMS radiances.*
    - **Derived Requirement 3.3.1:** *The NUCAPS trace gas profiles for GMAO shall meet performance specifications.*
      - **Derived Requirement 3.3.1.1:** *Trace gas profiles for GMAO shall have the following accuracy*
        - O3: 20%/5-km near tropopause*
        - O3: 10% total column*
        - CO: 40% mid-trop column (w/ 0.2 cm OPD SW band)*
        - CH4: 1% mid-trop column*
        - CO2: 1% mid-trop column*
        - HNO3: 50% mid-trop column. (product, performance)*



# NUCAPS Requirements – Basic Requirement 3.0

## (slide taken from TRR meeting)

- **Derived Requirement 3.3.1.2:** *Trace gas profiles for GMAO shall meet the following temporal specifications:*  
*Timeliness* of less than 3 hours after observation.  
*Latency* of no more than 15 minutes after granule data are available.
- **Derived Requirement 3.3.1.3:** *Trace gas profiles for GMAO shall meet the following spatial specifications:*  
*Global coverage.*  
*Horizontal resolution* of ≈50 km (Set of 9 CrIS FOV's collocated with ATMS FOR).
- **Derived Requirement 3.3.1.4:** *Trace gas profiles for GMAO shall include the vertical weighting functions.*

**Derived Requirement 3.4:** *The NUCAPS IPT shall perform tests to demonstrate that all trace gas profile products are being produced correctly and to user specification.*

- **Derived Requirement 3.4.1:** *The results of the tests on the trace gas profile products shall be documented in the validation and verification review (VVR).*



# NUCAPS Requirements – Basic Requirement 4.0

(slide taken from TRR meeting)

- **Basic Requirement 4.0:** *The NUCAPS shall generate CrIS Cloud-clear Radiance (CCR) products for NWP centers and CLASS.*
  - **Derived Requirement 4.1:** *The NUCAPS shall generate CrIS CCR products for GMAO.*
    - **Derived Requirement 4.1.1:** *CCR products for GMAO shall have an accuracy of less than 1 Kelvin.*
    - **Derived Requirement 4.1.2:** *CCR products for GMAO shall meet the following temporal specifications:  
*Timeliness* of less than 3 hours after observation.  
*Latency* of no more than 15 minutes after granule data are available.*
    - **Derived Requirement 4.1.3:** *CCR products for GMAO shall meet the following spatial specifications:  
*Global coverage.*  
*Horizontal resolution* of ≈50 km (Set of 9 CrIS FOV's collocated with ATMS FOR).*



# Future work towards the algorithm readiness review

- Validation test beds:
  - Full focus days of IASI/AMSU-A/MHS data
  - Full focus days of AIRS/AMSU data
  - Matched ECMWF and NCEP GFS analysis fields
  - Global matched RAOBs data
  - NOAA Aerosols and Ocean Science Expeditions (AEROSE)  
(Atlantic Ocean region)
- CrIS/ATMS proxy data set from IASI/AMSU-a/MHS SDRs:
  - Proxy data algorithm provided by Xu Liu and Kizer and Laura et al.
  - Work lead by Murty Divakarla. See next presentation.



# Future work using the CrIS/ATMS Proxy data generated from IASI SDRs

- Two-fold application:
  - 1) Validate the NGAS CrIMSS EDR algorithm by comparison with NOAA/NESDIS IASI EDR products, RAOBs, ECMWF data:
    - IASI mission as a risk reduction for the NGAS algorithm
  - 2) Validate NUCAPS EDRs by comparison with IASI as if they were seeing the same exact scenes (no temporal or spatial mismatch):
    - IASI mission as a risk-reduction for JPSS: the goal is to be launch ready!
- Currently working on NUCAPS retrieval channel selection, radiance tuning and first guess implementations. Stay tuned!



# NOAA IASI (& future CrIS) data available at:

<http://www.class.ncdc.noaa.gov/saa/products/welcome>

The screenshot shows the NOAA Comprehensive Large Array-data Stewardship System (CLASS) homepage. The left sidebar contains links for Around CLASS, User Account, Advanced Options, Release Info, and Other Links. The main content area features a banner for Hurricane Katrina (GOES 08/28/05) and a news item about the promotion of CLASS 5.4. A search bar is present, and the right sidebar is titled "SEARCH FOR DATA" with a list of various environmental data sets. A red arrow points to the "Infrared Atmospheric Sounding Interferometer 3X3 (IASI\_3X3)" entry in the list.

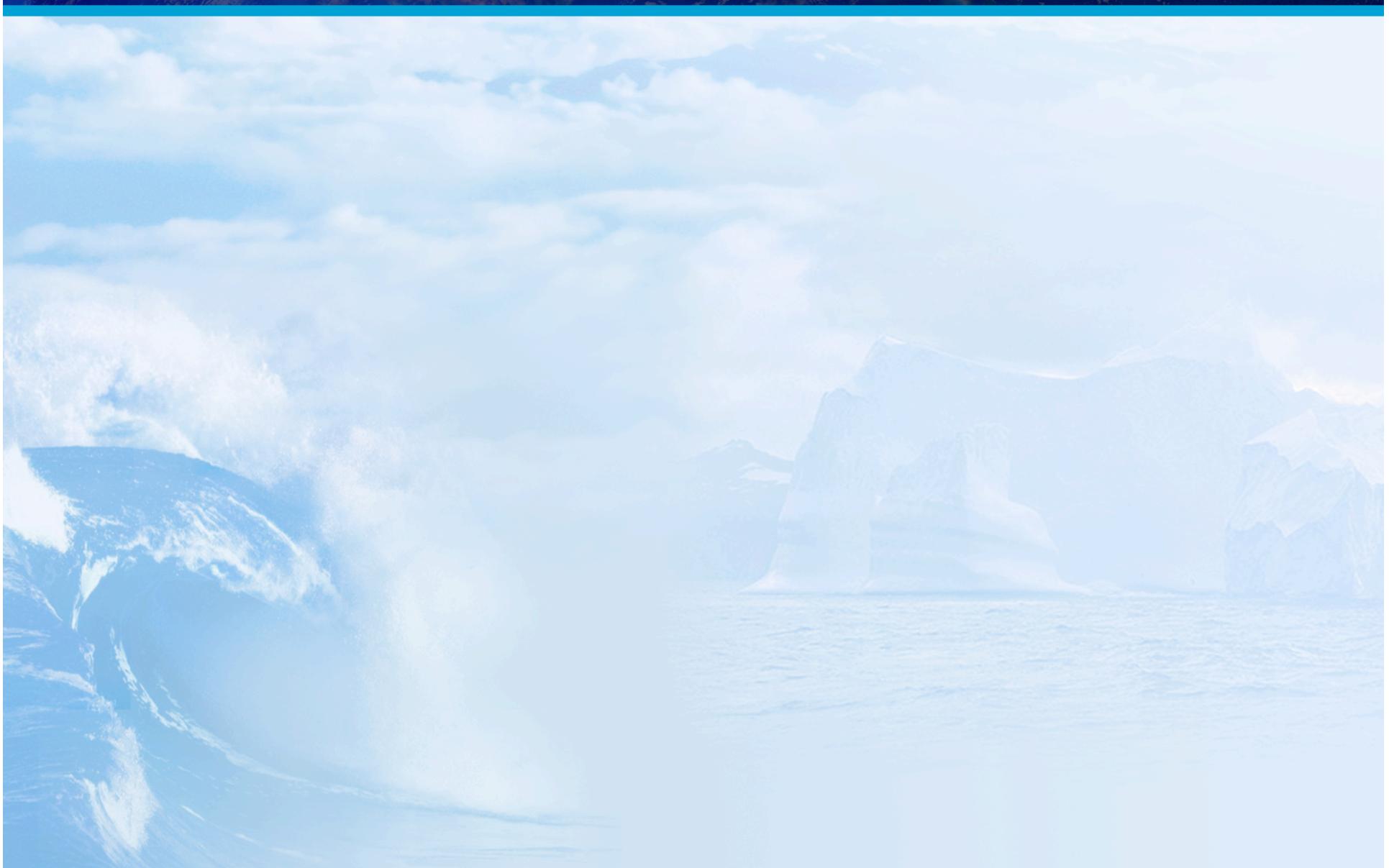
**SEARCH FOR DATA**

- Environmental Data from Polar-orbiting Satellites
  - Aerosol Optical Thickness (100 KM) (AERO100)
  - Advanced Scatterometer Level 1B (ASCAT)
  - Advanced Very High Resolution Radiometer (AVHRR)
  - Coast Watch full resolution swath files in hdf format (CWFULL)
  - CoastWatch Regions in HDF format (CW\_REGION)
  - CoastWatch, Alaska Regional Node (CWAL)
  - CoastWatch, Caribbean Regional Node (CWCAR)
  - CoastWatch, Gulf of Mexico (CWGM)
  - CoastWatch, Great Lakes Node (CWLAK)
  - CoastWatch, Hawaii Regional Node (CWHAW)
  - CoastWatch, Northeast Regional Node (CWNOE)
  - CoastWatch, Southeast Regional Node (CWSOE)
  - CoastWatch, West Coast Regional Node (CWWE)
  - Global Ozone Monitoring Experiment-2 Level (GOME)
  - Global Ozone Monitoring Experiment-2 Daily Data (GOME\_DAILY)
  - Global Ozone Monitoring Experiment-2 Level (GOME\_L2)
  - LIPS Comprehensive File (LIPS\_COMP)
- Infrared Atmospheric Sounding Interferometer 3X3 (IASI\_3X3)
- Infrared Atmospheric Sounding Interferometer Granule Data (IASI)
- MIRS Orbital data (mirs\_ORB)
- MSPPS Mapped Data (MSPPS\_FXAR)
- MSPPS Orbital Data (MSPPS\_ORB)
- Pathfinder (from AVHRR) (AVHRRPF)
- Radiation Budget Data (RBUD)
- Tiros Operational Vertical Sounder (TOVS)
- Environmental Data from Geostationary Satellites
- Defense Meteorological Satellite Program (DMSP)
- Sea Surface Temperature data (SST)
- RADARSAT

**CAVEAT: IASI level 1 and 2 data set under re-processing!**  
**Contact us for updates**



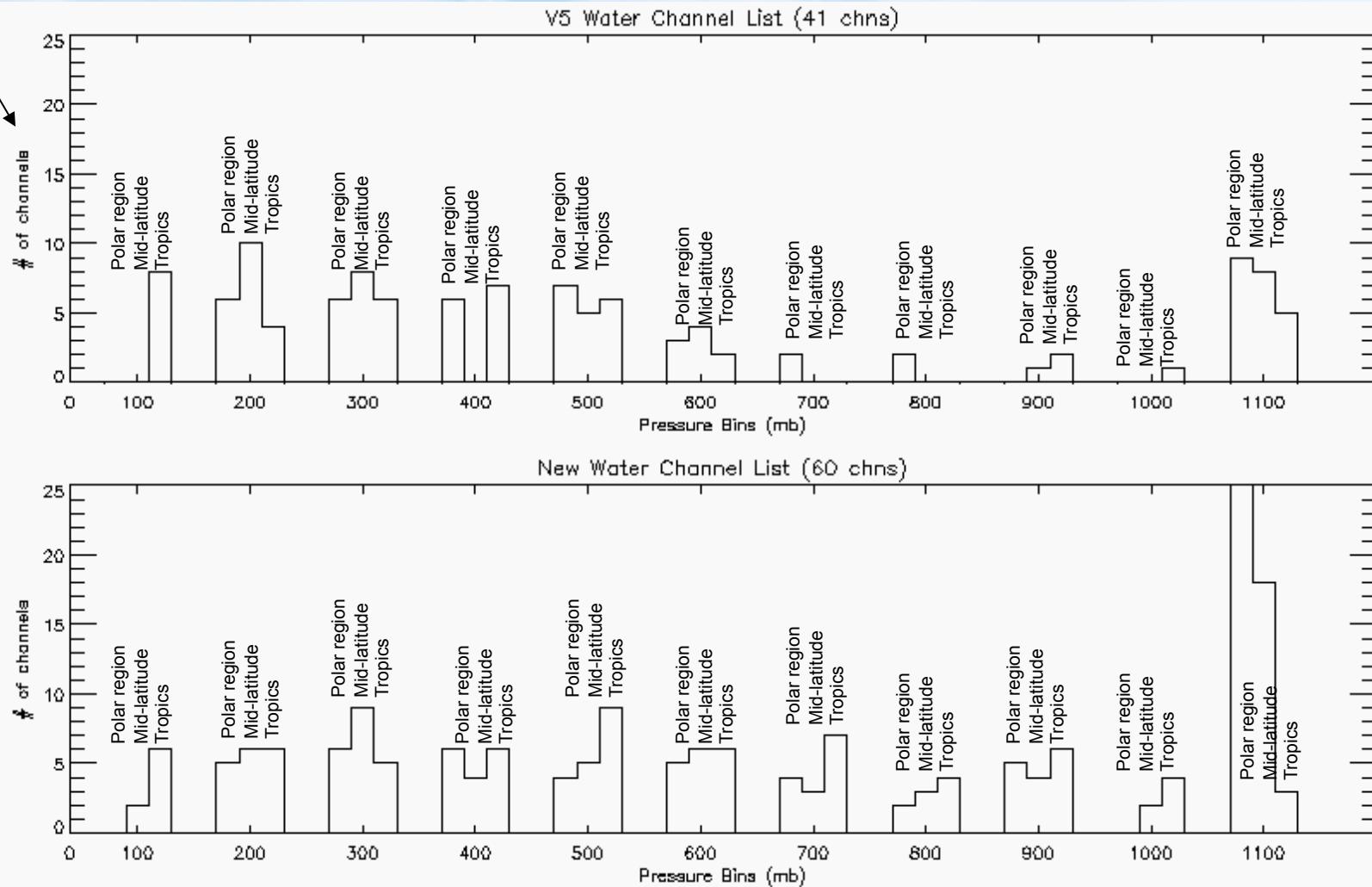
# Back up slides





# Chan. Selection comparison

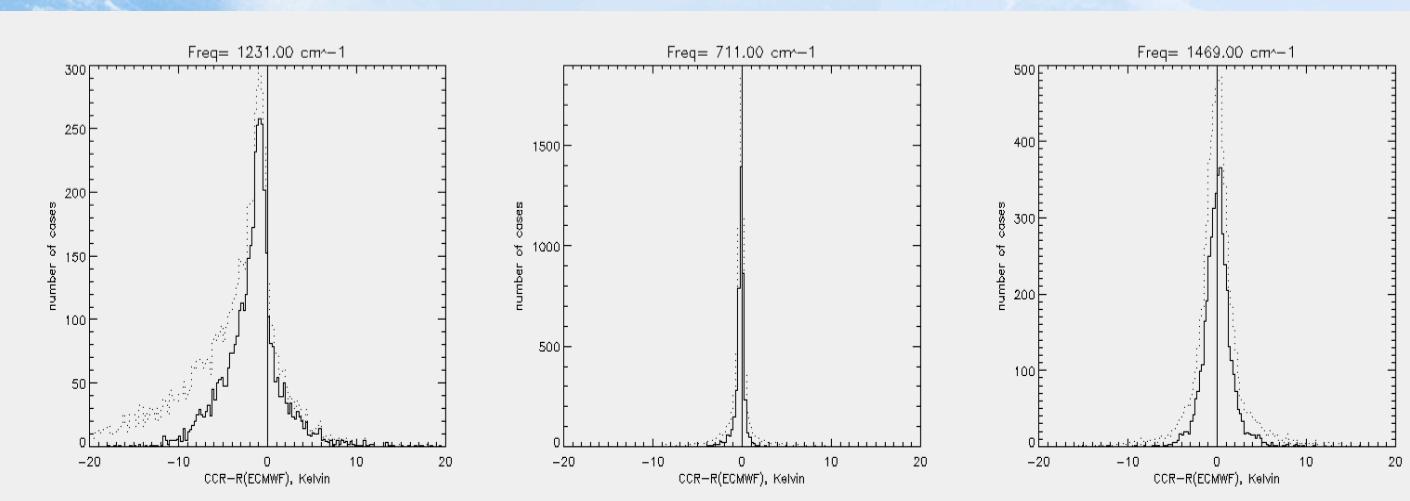
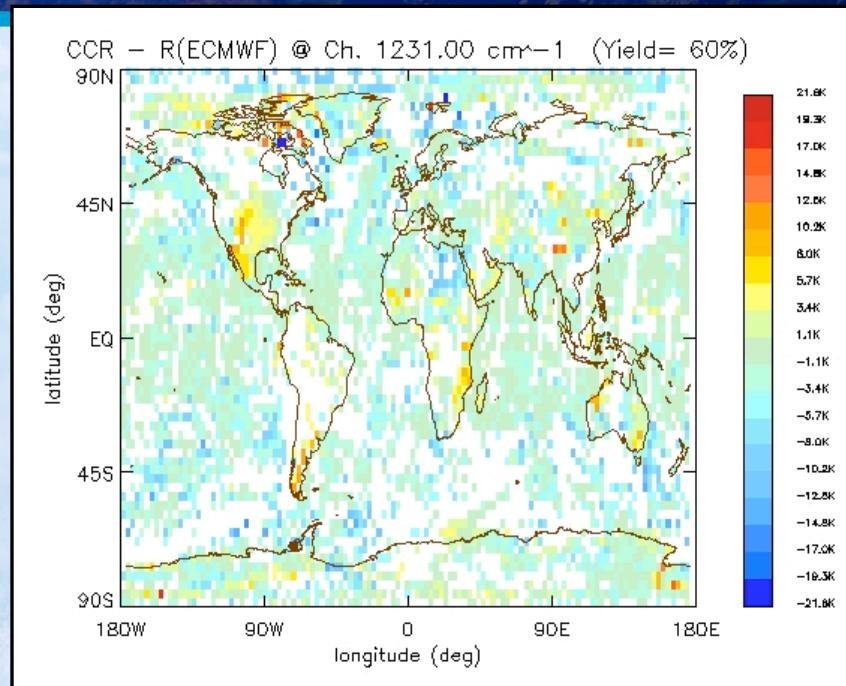
Number of channels whose transmittance is halved at a pressure level contained in a given pressure bin

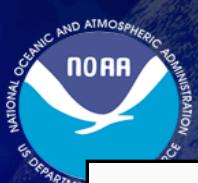




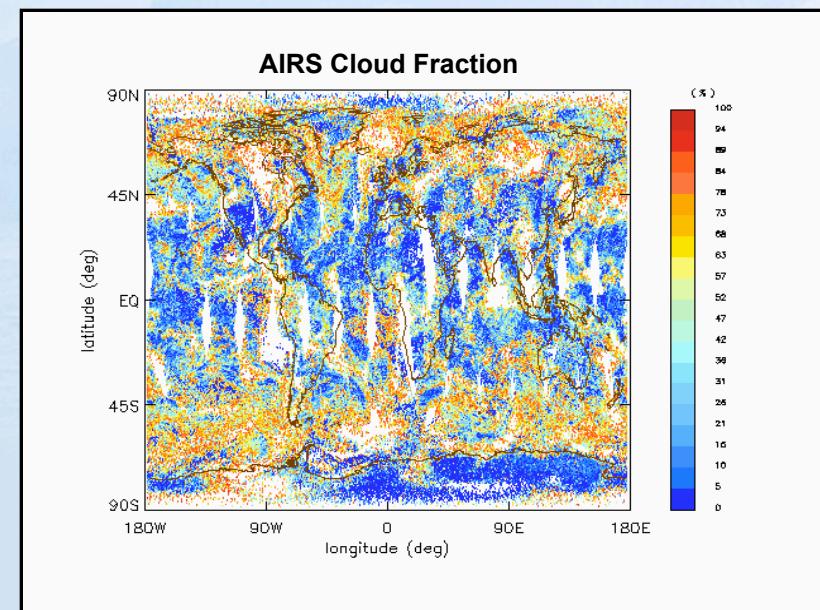
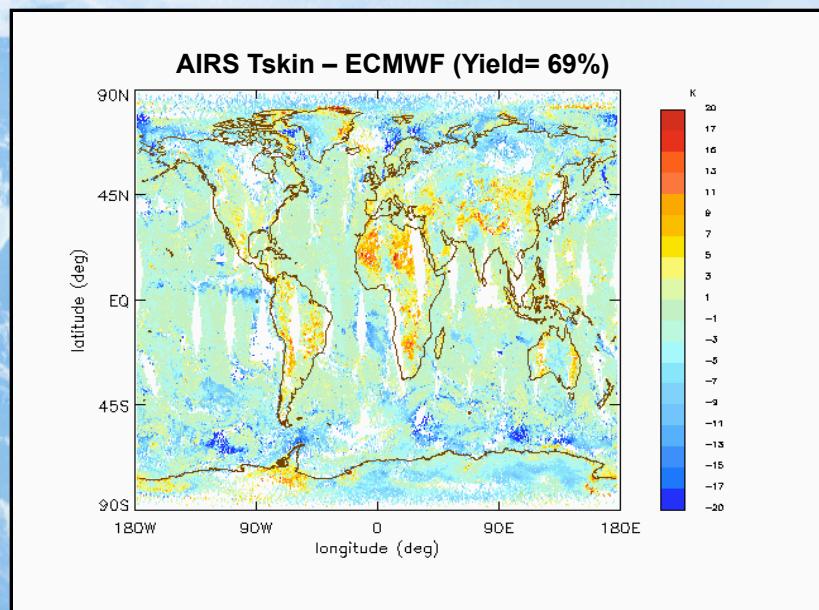
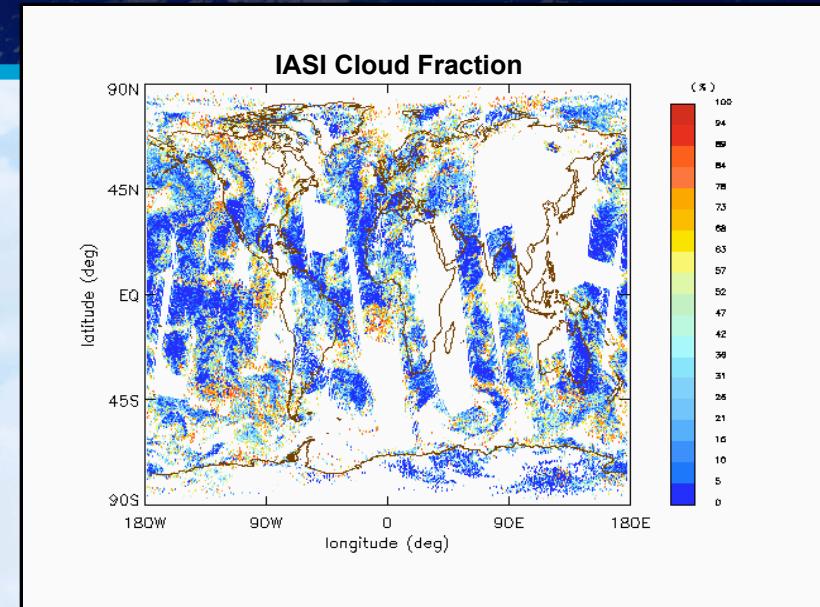
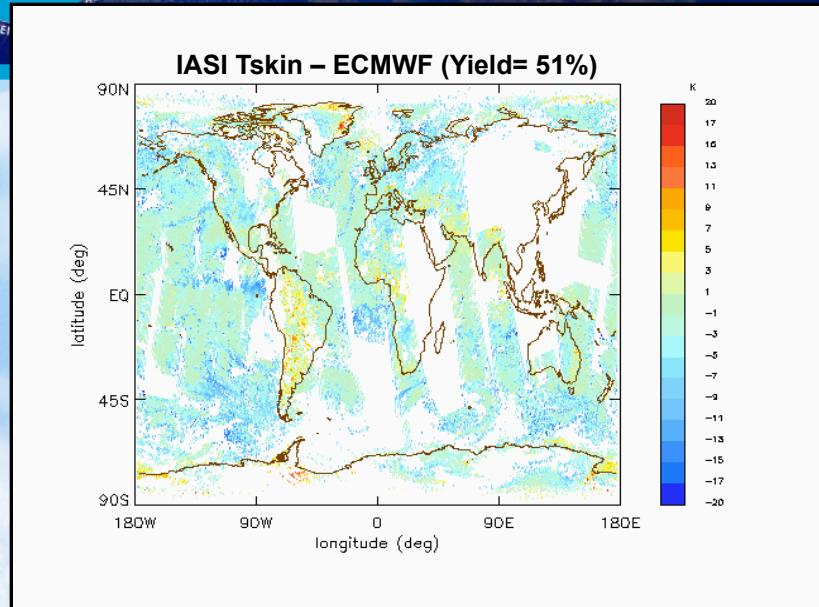
# CCR vs CALC(ECMWF)

## November 03, 2009 (IASI day orbit 3x3° grids)





# Focus day October 19, 2007





# Cloud cover: accepted and rejected cases

